The CSR-Firm Performance Missing Link: Complementarity Between Environmental, Social and Business Behavior Criteria?

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The Corporate Social Responsibility-Financial Performance Missing Link: Complementarity Between Environmental, Social and Business Behaviour?[1]

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This article analyses the complementarity between various dimensions of corporate social responsibility (CSR) and financial performance. We hypothesise that the absence of consensus in the empirical literature on the CSR-financial performance relationship may be explained by the existence of synergies (complementarity) and trade-offs (substitutability) between the different CSR components. We investigate such relationships using a sample of 595 firms from 15 European countries over the 2002-2007 period. The results suggest some kind of trade-offs between CSR components. Some CSR combinations appear as relative complements, human resources and business behaviour towards customers and suppliers, suggesting mutual benefits and less conflicts between those stakeholders. Conversely, environment and business behaviour towards customers and suppliers appear as relative substitutes, suggesting more conflict or over-investment between such types of stakeholders.

Keywords: Corporate social responsibility, financial performance, complementarity, supermodularity, panel data.
JEL Codes: M14 , L21, C33.

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1 Introduction

Considerable attention in the literature has been given to the relationship between corporate social responsibility (CSR) and financial performance over the past three decades, especially in the fields of management sciences and economics of organizations. However, no consensus has emerged so far on whether or not CSR leads to superior financial performance (for a survey see e.g. Margolis and Walsh, 2003 or Margolis et al., 2007). Hence many scholars still consider that much research needs to be conducted before this relationship can be fully understood (see e.g. Griffin and Mahon, 1997; Rowley and Berman, 2000; Surroca et al., 2010; Delmas et al., 2011).

Three main methodologies have been used in the literature to examine the link between environmental and social responsibility and financial performance. First, event studies examine the effect of new information on stock returns, considering that any information on environmental or social management should be reflected in how market analysts assess the financial impact of a firm's environmental or social management performance. Capital markets seem to react negatively to adverse news like environmental incidents and positively to good news such as the announcement that a firm is using cleaner technologies (see e.g. Dasgupta et al., 2001). Second, Best-in-class versus Worst-in-class studies compare the portfolio performance of firms considered the most responsible with irresponsible companies, or on the basis of negative screening of irresponsible firms. However, results appear relatively mixed in this literature (see e.g. Derwall et al., 2005 or Barnett and Salomon, 2006). The third category, econometric estimations, relies on environmental and social ratings (like KLD in the US or Vigeo in Europe) or on quantitative data (like that on emissions, corruption, rewards policy etc.) to measure environmental and social performance and test their impact on financial performance (see e.g. Elsayed and Paton, 2005; Scholtens, 2008; Horvathova, 2010; Iwata and Okada, 2011). This literature does not seem to reach a clear-cut conclusion on the relationship between CSR and firm performance. Several arguments have been developed to explain the contradictory results underlying this absence of consensus. Recent research points to numerous biases and problems in previous work (see e.g. McWilliams and Siegel, 2000; Elsayed and Paton, 2005) including the following: model misspecification (endogeneity), omitted variables in the determinants of profitability, limited data (small samples, old periods), cross-sectional analysis invalid in the presence of significant firm heterogeneity, problems of measurement of CSR, and the wide diversity of measures used to assess financial performance. Another problem lies in the direction and mechanisms of causation. Whether CSR leads to superior financial performance, or whether financial performance is rather a necessary condition for CSR is a major issue tackled by few papers (notable exceptions are Waddock and Graves, 1997; Margolis et al., 2007; Scholtens, 2008; Lioui and Sharma, 2012).

In this paper, we consider that the absence of consensus on the links between CSR and financial performance rather hides a double phenomenon: high performance in firms which simultaneously adopt some CSR practices that are relative complements, and low performance in firms which simultaneously adopt CSR practices that are relative substitutes (in this case, financial performance would be high when firms invest in one single practice but not all of them). Thus it should be a specific combination of CSR practices that would likely lead to

superior financial performance. In fact, being socially responsible means that, beyond legal constraints, firms commit on a voluntary basis to bear the cost of more ethical behaviour in a variety of practices: for example improving employment conditions and/or banning child labour in countries that do not respect human rights, protecting the environment and investing in abatement equipment to reduce the carbon footprint, developing partnerships with NGOs, or providing funds to charity, etc. (European Commission, 2001). Therefore, CSR is inherently multi-faceted and implies a multi-dimensional decision. Researchers often group those different dimensions into three main pillars: environmental, social and corporate governance (so-called ESG factors). Hence, as pointed out by Benabou and Tirole, (2010) the different dimensions of CSR need to be considered, since firms can do well in some dimensions and poorly in others. But why would firms decide to implement some CSR practices rather than others? Are there specific synergies and trade-offs among the different CSR practices so that to be effective companies should accompany the implementation of one CSR practice with other appropriate CSR practices? In other words, are the multiple dimensions of CSR practices complementary (leading to synergistic effects on financial performance when adopted together) or substitutable (leading to improved financial performance in isolation, only when they are not adopted simultaneously)?

The main proposition of this paper is to investigate the interactions between the multiple dimensions of CSR that mediate the relationship between CSR and financial performance, and analyse how this mediation operates through synergies (complementarity) and trade-offs (substitutability) between each pair of CSR practices. We use an international matched CSR-Firm performance database provided by the European extra-financial agency Vigeo over the 2002-2007 period. Our sample of 595 firms from 15 European countries is a useful complement to existing studies, which often focus on US companies based for instance on KLD data. We use two types of CSR measures available in our dataset: scores and ratings attributed over three broad CSR domains, human resources, environment and business behaviour (towards customers and suppliers).

On the methodological side, we rely on an original two-step approach to test how complementarity or substitutability between the different CSR practices affects the relationship between CSR and financial performance. In a first step, we exploit the dynamic dimension of our dataset through the system GMM (Generalised Method of Moments) technique and estimate the impact of CSR scores on financial performance. In a second step we test explicitly the complementarity between the environmental, human resources and business behaviour dimensions using industry-adjusted ratings. We do find some combinations are complementarity inputs of financial performance: human resources and business behaviour; while others are substitutable inputs of financial performance: environment and business behaviour in the supply chain.

The remainder of the paper is organised as follows. In Section 2, we derive a theoretical rationale to support our hypotheses on synergy (complementarity) and trade-off (substitutability) between CSR practices. We present our data and variables in Section 3, and the empirical strategy in Section 4. Section 5 derives the results and section 6 concludes.

2 Synergies between CSR practices and financial performance: theoretical rationale

As CSR is a multi-dimensional construct, the different dimensions need to be taken into account when analysing its impact on financial performance (Carroll, 1979; Hillman and Keim, 2001; Benabou and Tirole, 2010). The resource-based view of the firm considers that a firm might perform better than its competitors depending on a unique interplay of human, physical, and organisational resources over time, and that some complementary resources are most likely to lead to competitive advantage, in particular those that are valuable, rare and inimitable (Lippman and Rumelt, 1982; Barney, 1991). Similarly, during the 1990s, the complementarity between different managerial practices proved a useful explanation of the Solow paradox, whereby "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). Indeed, studies have shown that only those firms that adopted both computerization and complementary innovative human resources management practices (teamwork, multi-tasking, quality circles, etc.) enjoyed superior performance (see Ichniowski and Shaw, 2003). By analogy, we hypothesise here that the apparently ambiguous link between CSR and financial performance could presumably be explained by taking into account the complementarity between the different dimensions of CSR (environmental, social and corporate governance). In other words, the absence of a clear-cut impact of various CSR practices on financial performance would hide the fact that two types of CSR 'models' can be valued on the market (i.e. can lead to higher financial performance).

The first model exploits synergies among different CSR practices and corresponds to companies investing in complementary CSR practices. Complementarity between two practices means that investing in one responsible practice (for example towards customers and suppliers) increases the value of investing in another responsible practice (for example towards employees). In this case, as stated in the conflict-resolution hypothesis, firms tend to use CSR activities to reduce conflicts of interest between managers and the firm's stakeholders (Harjoto and Jo, 2011). From a theoretical perspective, the complementarity (or conflict-resolution) hypothesis may be explained using the stakeholder management theory (Freeman, 1984; Clarskon, 1995) according to which building better relations with primary stakeholders like employees, customers, suppliers, and communities could lead to increased financial returns by helping firms develop intangible but valuable assets which can be source of competitive advantage (Hillman and Keim, 2001). If the conflict-resolution motive is correct, firms will use complementary CSR practices to reduce conflict between various stakeholders. Lessened conflict, reduced agency problems among those stakeholders, will result in higher financial performance (Harjoto and Jo, 2011). For instance, the Ford Motor Company has developed an innovative project - the Supply Chain Sustainability group - in order to promote its CSR priorities in the supply chain (the business behaviour component), along with a Code of Basic Working Conditions covering workplace issues such as compensation, freedom of association and collective bargaining, harassment and discrimination, health and safety, and work hours (the social component).[4] Thus we propose the following hypothesis:

4 For further details see the case study by Dold (2009).

Hypothesis 1: Complementary CSR practices are positively associated with financial performance when they are combined and therefore simultaneously implemented (conflict-resolution motive).

The second model exploits substituabilities and corresponds to companies which deliberately invest in one responsible practice (for example towards the environment) to the detriment of other responsible practices (for example towards customers and suppliers) because investing in both of them is too costly, or because investing in one of them decreases the relative value of investing in the other one. In this case, substitutability will lead to over-investment related to costs when firms decide to invest simultaneously in several substitutable CSR practices. From a theoretical perspective, the substitutability (or over-investment) hypothesis may be explained using the principal-agent theory (Jensen and Meckling, 1976) whereby top management would tend to over-invest in CSR activities to build their own personal reputation as good global citizens (Barnea and Rubin, 2006). If the over-investment hypothesis is correct, then we expect that firms are less likely to engage in multiple CSR practices since higher performance is associated with less over-investment, less agency problems (Gompers, Ishii and Metrick, 2003).

For instance, the high performing Wal-mart group is developing an ambitious plan to boost energy efficiency, cut down on waste and reduce greenhouse gases tied to global warming (environmental component), but remains highly criticiced by NGOs notably for its business practices and extensive foreign product sourcing, treatment of employees and product suppliers.[5] Thus we propose the following hypothesis:

Hypothesis 2: Substitutable CSR practices are positively associated with financial performance when implemented in isolation (that is when they are not combined and not implemented simultaneously), and negatively associated with financial performance when they are adopted simultaneously (over-investment motive).

What type of CSR practices may be complementary or substitutable inputs of financial performance? This question can be answered by relying on the New Stakeholder View (Post, Preston and Sachs, 2002) which posits that the capacity of a firm to generate long term financial performance is determined by its relationship with critical stakeholders. Some stakeholders have common interests while others have potential conflicts and the various stakeholders of the firms are positioned in relation to three strategic dimensions: resource-base, industry-market, and social-political arena. The resource-base stakeholders are suppliers of capital, labour, and customers/users; the industry-market stakeholders are supply chain associates, joint venture partners and alliances, regulatory authorities and unions; and the social-political arena stakeholders are composed of governments, communities, and NGOs. While the first two categories refer to direct 'business' or 'voluntary' stakeholders (critical business stakeholders such as investors, employees and customers, and peripheral business stakeholders such as supply chain associates, unions, regulatory authorities), the third category refers to 'non

5 For further details on Wal-Mart's business policies see the case study by Lussier (2008). Management Fundamentals: Concepts, Applications, Skill Development. South-Western College Pub, p.77-78.

business' or 'involuntary' stakeholders (concerning community relations and environmental issues, that is stakeholders who are rather adversely affected by externalities such as pollution or congestion). In the new stakeholder theory the basic principle with respect to voluntary business stakeholders is mutual benefit, and with respect to involuntary non-business stakeholders the basic principle is avoidance of harm. Applying such an argument to the management of multi-dimensional CSR would mean that some CSR practices may have a synergistic impact on financial performance (those based on mutual benefit between voluntary stakeholders, for instance between employees and supply chain associates), while others may lead to conflicts among stakeholders (between voluntary and involuntary stakeholders, for instance between supply chain associates and environmental management) thereby leading to reduced impact on financial performance. In our framework, this implies that there should be some synergies (i.e. complementarity) between CSR practices that positively affect voluntary business stakeholders and some trade-offs (i.e. conflict or substitutability) between CSR practices that positively affect business and non-business stakeholders. Thus we propose the following hypothesis.

Hypothesis 3: CSR practices are complementary inputs of financial performance when they positively affect only voluntary business stakeholders (due to mutual benefit), and they are substitutable inputs of financial performance when they positively affect voluntary business and involuntary non-business stakeholders (due to conflict among stakeholders).

3 Data and variables

Our analysis is based on a panel of CSR and financial performance data for the 300 biggest European listed (publicly-traded) firms over the 2002-2007 period. CSR is measured thanks to the database of Vigeo, the leading European CSR rating agency. Financial performance variables come from the Orbis dataset (Bureau Van Dijk), a comprehensive database from the companies' standardised annual accounts, consolidated and unconsolidated, together with their financial profiles. In order to avoid the sample selection issue, we do not require a balanced panel. Thus, the number of firms in our sample differs year to year and the estimation strategy uses as many observations as available. Moreover, in order to exploit the dynamic dimension of our database (i.e. to introduce the lagged value of the dependent variable), we have to observe firms over at least two consecutive years. We thus exclude firms that do not provide complete information. Our final unbalanced panel sample comprises 1094 observations (around 300 firms per year) in 15 countries over the period 2002-2007.

3.1 Firms' characteristics and financial performance

Variables measuring firms' characteristics and financial performance are extracted from the Orbis database, which contains information combined from nearly 100 sources (Datamonitor, Zephyr, Coface etc.) filtered into various standard report formats. The dataset has up to 25 data sections and 10 years of history, including detailed information from the

companies' standardised[6] annual accounts, consolidated and unconsolidated, together with financial profile (balance sheet, P&L account, financial ratio), activities and ownership (cash flow, total assets, intangible assets valuation etc.), profitability ratio (profit margin, solvency ratio etc.) and operational and structure ratios.

We use two types of variable from the Orbis dataset. The first type of variable represents the firms' characteristics in terms of operational and financial structure. To explain financial performance, the usual control variables are considered (see e.g. Waddock and Graves, 1997; Baron et al., 2008; Scholtens, 2008; Surroca et al., 2010): firm size (sales); total assets; and debt ratio. To control for the sensitivity to stock market variations, we introduce a dummy variable identifying firms listed on the Dow Jones STOXX600 index. Moreover, to control for differences between countries and industries, we include country and industry dummies according to the two-digit sectoral classification (NES16) provided by INSEE (the French National Statistical Office), which is widely used for the national accounts. To control for macroeconomic variations and business cycle fluctuations, we introduce yearly dummies (year fixed effects).

Finally, we also introduce two important variables: a Research and Development (R&D) intensity and an advertising ratio. Indeed, omitting these variables would likely give misleading results. Regarding R&D expenses, the process of product differentiation may in fact include investment in R&D projects to add social and environmental attributes to the product, and that are acknowledged by customers (Elsayed and Paton, 2005). Similarly, Lioui and Sharma (2012) show that the interaction between CSR and R&D efforts has a positive impact on financial performance. Moreover, advertising may help to raise consumer and investor awareness of environmental and social-friendly products. The R&D intensity indicator is measured by R&D expenses divided by total sales. In order to keep a maximum of firms in the sample and because of missing data on R&D expenses, we use a standard statistical technique which consists of controlling for the absence of reported R&D expenditures in the annual accounts by including in the estimations a dummy variable taking the value of 1 if R&D expenses are not reported by firms and 0 otherwise. Following Elsayed and Paton (2005), we also include the ratio of total intangible assets to total sales in order to capture a proxy for advertising.

The second set of variables from the Orbis database characterises financial performance. We consider two variables to assess the diversity of financial performance measures. Traditionally, financial performance is measured by accounting or by market-based indicators. Both types of measures represent different perspectives on the value of financial performance. Accounting measures, such as return on assets, return on equity or return on sales, capture the historical aspects of financial performance and are therefore backward-looking (McGuire et al., 1986). The accounting measure we use is the return on assets (ROA). We also rely on a market performance measure, the Tobin's Q, which is a measure of return based on the stock market (market value of a company's stock compared to the value of a company's equity book value). The Tobin's Q represents the investors' evaluation of the ability of a firm to generate future economic earnings and is therefore forward-looking. Hence the Tobin's Q can be considered as a proxy for growth opportunities. This financial performance indicator thus seems more appropriate to capture the expected future impact of CSR on financial performance (Hillman and Keim, 2001). The Tobin's Q also is expected to better

6 Orbis information is standardised given the differences in accounting practices across countries.

capture the value of long-term investments (see Dowell et al., 2000; Surroca et al., 2010). Note however that the Tobin's Q may be sensitive to variations that are independent of the operations and social activities of firms, like macroeconomic shocks and political issues, or to industry-specific factors such as rising or falling prices due to shifts in industry demand or restrictions on supply, as in the case of oil or other raw materials. Introducing year and industry dummies allows the capture of such factors.

3.2 Corporate social responsibility variables

To measure CSR, we rely on the Vigeo database. Vigeo is the leading European extra-financial rating agency and evaluates the CSR performance and risk factors on Environmental, Social and Governance (ESG) criteria of European firms listed on the DJSTOXX 600 and MSCI World indexes (595 European firms). It supplies this information to investors and asset managers notably. Vigeo (formerly known as ARESE) can be considered as the European counterpart of KLD, with comparable methods. Igalens and Gond (2005) in fact compare KLD and Vigeo data and quote few differences explained mainly by different cultural sensitivities.

Vigeo's Methodology

Vigeo measures CSR on a positive screening basis (identifying companies that are the best performers on various indicators) on six broad domains or dimensions: human rights, environment, human resources, business behaviour towards customers and suppliers, corporate governance, and community involvement. For each dimension, there is a subset of criteria describing how the firm manages the particular aspect of CSR. However, not all of the six domains are investigated by Vigeo for the whole sample because before companies are rated, an analysis is done to identify the key CSR issues within the business sector. This determines which criteria in each of the six domains will be activated in each sector. Vigeo's analysis then focuses on how each company addresses each criterion in terms of Leadership, Implementation, and Results. The evaluation is realised by Vigeo via a questionnaire, and not by the firms themselves. The ratings model is based on internationally recognised CSR standards. For each criterion, the questionnaire is based on three items and nine approaches. For all criteria a weight is defined depending on a sectoral analysis done by Vigeo and depending on three considerations: CSR criteria of a sensitive nature for the firm, CSR criteria of a fundamental nature for the firm, and CSR criteria of a vital nature for the firm.

Vigeo provides two types of evaluation of CSR practices: scores and ratings. Scores are established on a scale from 0 to 100 (a firm's absolute score), so that a score of 0 shows little evidence of commitment (poor to very poor guarantee of risk management), whereas a score of 100 shows an advanced commitment (social responsibility objectives actively promoted). These scores are continuous variables. Ratings are attributed depending on how far scores deviate from the average in the sector. In each domain the firm may be ranked as the least performing, below average performer, average performer, active performer or leading performer in the sector. [7]

7 Additional details on Vigeo's methodology are available here:

Measuring CSR

To measure CSR, we rely on scores and ratings provided by Vigeo. For CSR ratings, the firm's relative ranking within the sector (ratings) is represented by a dummy variable that takes the value of 1 (resp. 0) if the firm is ranked above (resp. below) the sectoral average in the corresponding CSR domain. This represents a measure applicable to different firms across sectors and comparable across different CSR practices. These relative rankings can be considered as industry-adjusted ratings. In addition to scores on each CSR dimension, we also build an aggregate CSR score by computing an average of the different CSR scores in order to have a global measure of the impact of CSR on financial performance. Note however that such an aggregate score is usually considered as an imperfect measure of CSR given the multiple dimensions of CSR (see Chen and Delmas, 2011).

Regarding the different dimensions of CSR, we restrict our analysis to three CSR dimensions: environment, human resources and business behaviour towards customers and suppliers. This restriction is motivated by the fact that, as explained above, not all criteria in each of the six CSR dimensions are activated for each sector and this leads to many missing data when taking into account all six CSR dimensions. In particular, the human rights and community involvement criterion is not specified for all firms. Moreover, corporate governance ratings are very stable across time and sectors (this dimension of CSR is most likely determined between shareholders and boards of directors, and is traded-off by managers to a much lesser extent than the other components of CSR). We therefore choose not to rely on this criterion in our empirical analysis. The three CSR dimensions are composed of the following criteria:

- Human resources: integration of human resources issues into corporate strategy; promotion of labour relations and employee participation; career development and training; quality of working conditions (remuneration systems, health and safety conditions, working hours)
- Environment: integration of environmental issues into corporate strategy (environmental strategy and eco-design, pollution prevention and control - soil, accidents, development of green products and services, protection of biodiversity); incorporation of environmental considerations into the manufacturing and distribution of products (protection of water resources, minimising environmental impacts from energy use, management of atmospheric emissions, waste, local pollution and environmental impacts from transportation); management of environmental impacts from the use and disposal of products/services
- Business behaviour in the supply chain (towards customers and suppliers): customers (product safety, information to customers, responsible contractual agreements); suppliers and subcontractors (sustainable relationships with suppliers, integration of environmental factors in the supply chain, integration of social factors in the supply chain); business integrity (prevention of corruption and anti-competitive practices).

From a theoretical point of view, those three CSR dimensions allow the capture of how the firm manages its relationship with the two types of stakeholders highlighted in section 2:

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http://csr.bilsp.org/presentations/en/Presentation%20Martine%20Combemale.pdf

voluntary business stakeholders for the human resources and customers and suppliers dimensions; and involuntary non-business stakeholders for the environmental dimension. Our empirical analysis hence allows testing of whether the impact of CSR on financial performance relies on a positive relationship between complementary CSR practices (among voluntary stakeholders) and a negative relationship between substitutable CSR practices (between voluntary and involuntary stakeholders).

Definition and descriptive statistics of the variables describing firm characteristics, financial performance and CSR scores are reported in Tables 1 and 2 respectively. If CSR scores are highly persistent, this can reduce the power of any panel data estimator. As we can see in Table 3 reporting the summary statistics of CSR scores between 1993 and 2007, this is not the case.

Table 1: Variables definition

Variable	Definition
Firm variables:	
Tobin's Q	(Market value of common equity+preferred stock+total debt)/total assets
ROA	Return on assets = net profits/total assets
Lsales	Log of firm's annual net sales
Ltotal assets	Log of firm's annual total assets
Debt ratio	Long term debt divided by total assets
R&D ratio	Research and Development expenses/total sales
NoR&D	= 1 if firms have R&D expenses missing
DJSTOXX600 index	= 1 if firms are listed in the DJSTOXX600 index
Advertising ratio	Total intangible assets/total sales
CSR dimensions:	
HR score	Human resources score (over 0-100)
ENV score	Environmental score (over 0-100)
BB score	Business behaviour towards customers and suppliers score (over 0-100)
HR dummy	= 1 if HR ranking equal or above average in the sector and 0 otherwise
ENV dummy	= 1 if ENV ranking equal or above average in the sector and 0 otherwise
BB dummy	= 1 if BB ranking equal or above average in the sector and 0 otherwise
CSR global	(sum of the 3 scores: HR, ENV and BB)/3

Table 2: Descriptive statistics

Variable	Mean	SD	Min	Max
Tobin's Q	1.28	1.17	0.11	11.26
ROA	1.80	0.76	-3.90	2.99
Lsales	15.64	1.36	11.64	19.55
Ltotal assets	15.98	1.33	11.97	19.45
Debt ratio	0.20	0.14	0	1.13
R&D ratio	0.02	0.05	0	0.72
NoR&D	0.58	0.49	0	1
DJSTOXX600 index	0.86	0.35	0	1
Advertising ratio	0.33	0.46	0	5.30
HR dummy	0.66	0.47	0	1
ENV dummy	0.67	0.46	0	1
BB dummy	0.64	0.47	0	1

Table 3: Summary statistics of CSR over 2002-2007

	2002	2003	2004	2005	2006	2007	2002-2007
HR score	53	49	39	35	33	29	42
ENV score	55	50	35	30	34	27	41
BB score	54	48	36	36	37	39	44
CSR global	54	49	37	33	35	31	42

Tables 4, 5 and 6 show that average scores exhibit differences across countries and sectors. We see from Table 4 that the best performances in terms of human resources (HR score) are observed in France, Norway, the Netherlands, and Germany. The best performances on environmental issues (ENV score) are observed in Norway, Germany and the United Kingdom. Finally, the United Kingdom, the Netherlands, Finland, and Norway report the highest scores on business behaviour towards customers and suppliers (BB score). For both the social and environmental domains, Greece and Ireland report the lowest scores. It is thus worth controlling for countries' differences as CSR practices are likely to depend on the legal system. We also introduce year fixed effects.

Furthermore from Tables 5 and 6, we observe clear differences in CSR across industries. Some dimensions of CSR may be more important for specific industries and not so much for others. Table 5 reports the average industry CSR scores. We can see that the best CSR scores are obtained in sectors which have a negative public image on environmental or social issues, i.e. controversial industries such as automobile, transport and energy. This is consistent with Cai et al. (2012) observing that CSR in controversial industries would positively affect firm value. The least-performing sectors on both environmental (ENV) and social (HR) issues are the media and hotel industries. From Table 6, we see that the percentage of firms with CSR scores above the sectoral average is decreasing over the period. This may reflect both an increasing competition between firms and a stricter international regulation imposing tighter constraints and/or stronger market contestability on those dimensions of CSR. The descriptive analysis highlights the importance of controlling for sectors when estimating the CSR-firm performance relationship. Thus in section 5.2, we explore if there are some specific industrial patterns.

The estimation of unconditional correlations (e.g. Spearman rank correlation) between the three CSR scores (see Table 7) shows that business behaviour (BB), environmental (ENV) and human resources (HR) scores are positively correlated. But since correlations might be induced by unobserved factors, we cannot conclude the existence of complementarities from these types of results.

Table 4: CSR average scores per country

	HR score	ENV score	BB score	CSR global
Belgium	33	36	26	32
Denmark	33	35	35	34
Finland	42	37	38	39
France	43	35	40	39
Germany	42	40	40	41
Greece	19	15	21	18
Italy	33	30	34	32
Ireland	17	14	25	19
Netherlands	42	37	43	41
Norway	44	43	39	42
Portugal	37	37	33	36
Spain	35	35	31	34
Sweden	33	38	41	37
Switzerland	36	37	40	38
United Kingdom	37	41	42	40

Table 5: CSR average scores per sector

	HR score	ENV score	BB score	CSR global
Agricultural and food	28	27	40	32
Auto	42	41	40	43
Construction	32	34	34	33
Consumption	28	25	37	30
Energy	43	43	40	42
Equipment	28	20	38	29
Finance	42	35	45	41
Hotel	23	19	35	26
Intermediary	39	39	40	39
ITC	31	24	37	31
Media	24	21	33	26
Telecom	42	38	40	40
Trade	28	29	40	32
Transport	35	40	40	38

Table 6: Firms with CSR ratings above the sectoral average (%)

	2002	2003	2004	2005	2006	2007
HR dummy	75	69	72	67	66	65
ENV dummy	78	71	68	65	70	66
BB dummy	82	66	65	64	67	63

Table 7: Pairwise correlations between CSR scores

	HR	ENV	BB
Human Resources (HR)	1		
Environment (ENV)	0.46	1	
Business Behaviour (BB)	0.45	0.44	1

4 Methodology

On the methodological side, we rely on an original two-step approach to test our three hypotheses proposed in section 2, that is to test how the complementarity and/or substitutability between the different CSR dimensions (human resources, environment, business behaviour) affects the relationship between CSR and financial performance (measured by ROA and Tobin's Q). In the first step, we use CSR measured by scores and exploit the dynamic dimension of our dataset through the system GMM (Generalised Method of Moments) technique and estimate the impact of CSR scores on financial performance. In particular, this method allows us to take account of endogeneity and causality between CSR and financial performance. Moreover, we explore if there are some industry patterns, i.e. whether the impact of CSR on financial performance varies across different industries. Then in the second step we test explicitly the complementarity between the relative ratings on environmental, human resources and business behaviour using a technique developed by Kodde and Palm (1986). We are thus able to determine which dimensions are complementary and which are relative substitutes inputs of financial performance.

4.1 Empirical strategy

From a methodological point of view, we have to cope with three issues. First, by exploiting the dynamic structure of our data, we consider that past financial performance may explain current financial performance (see Surroca et al., 2010). Second, when we investigate the relationship between CSR and financial performance, current financial performance is likely to be correlated with both observable and unobservable factors (i.e. observable and unobservable heterogeneity) which also determine CSR decisions. In particular, firms relying on high quality processes and products tend to have higher CSR commitments. In turn, the contribution of CSR to financial performance will be overstated if we do not correct for endogeneity problems. Finally, causality may run in both directions, that is from CSR to financial performance and from financial performance to CSR. We therefore need to take into account such a causality.

We estimate the relationship between financial performance, labelled Π_{it} (ROA or Tobin's Q), by its lagged value, Π_{it-1}, the CSR variables (scores or rating dummies as defined before), CSR_{it} and a set of firm-level control variables (lsales, ltotal assets, debt ratio, R&D ratio, advertising ratio, industry and country dummies, yearly dummies), labelled X_{it}, according

to the following equation:

$$\Pi_i t = \alpha + \beta \Pi_{it-1} + \gamma CSR_{it} + \delta X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where i refers to firm, t to time, μ_i are unobserved firm-specific fixed effects and ε_{it} is the error term.

Two traditional potential sources of endogeneity may arise when we estimate Eq.(1): unobservable heterogeneity (which arises if there are unobservable factors that affect both the dependent and explanatory variables) and simultaneity (which arises if the independent variables are a function of the dependent variable or the expected values of the dependent variable). Moreover, one additional source of endogeneity that is often ignored arises from the possibility that current values of CSR are a function of past financial performance. Here, we argue that the cross-sectional variation in observed CSR is driven by both unobservable heterogeneity and the firm's history.

One potential solution to the problem of simultaneity is to estimate the effect of CSR on financial performance using a system of equations taking into account all the CSR dimensions. However, estimating with this system requires us to identify strictly exogenous instruments. It has traditionally been difficult to identify and justify a strictly exogenous instrument. A fixed-effects model can potentially ameliorate the bias arising from unobservable heterogeneity but such a model assumes that current observations of the explanatory variable are completely independent of past values of the dependent variable. Here, we consider that current levels of CSR scores are related to past financial performance, and so we follow Wintoki et al. (2012) and examine this assertion with a series of tests involving OLS regressions of current levels of CSR scores and other firm-specific variables [8] and changes in these levels on past performance and historical values of the firm-specific variables.

Table 8 reports the results of OLS regressions of current levels of CSR scores and changes in these levels on past performance (ROA & Tobin' Q) and past values of the firm-specific variables. OLS regressions of the levels of CSR scores on past financial performance show that CSR scores are significantly negatively related to past financial performance for ROA and positively related to Tobin's Q (except for the environmental score regarding ROA). These results underline that the Tobin's Q may more likely capture the value of long-term investments. The results from OLS regressions on changes in CSR scores are similar to those obtained on levels. Thus, we can conclude that CSR is dynamically endogenous (CSR is determined by past financial performance) and we need an econometric technique that accounts for such a dynamic endogeneity process when we estimate the impact of CSR on financial performance.

8 Results are not reported here but are available from the authors upon request.

Table 8: Relationship between CSR scores and past financial performance

	HR	ENV	BB	CSR global
Dependent variable is level at time t:				
ROA (t-1)	-0.106*	-0.027	-0.003**	-0.004**
	(0.056)	(0.018)	(0.00)	(0.001)
Dependent variable is level at time t:				
Tobin's Q (t-1)	0.014	0.096**	0.077**	0.026**
	(0.022)	(0.027)	(0.049)	(0.013)
	Δ HR	Δ ENV	Δ BB	Δ CSR global
Dependent variable is change from t-1 to t:				
ROA (t-1)	-0.003	-0.024**	-0.003**	-0.004**
	(0.002)	(0.010)	(0.001)	(0.002)
Dependent variable is change from t-1 to t:				
Tobin's Q (t-1)	0.051**	0.109**	0.022**	0.026**
	(0.022)	(0.054)	(0.011)	(0.012)

Robust standard errors in parentheses
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$
The other control firm variables included in the estimations but not reported here are:
Ltotal assets (t-1), Lsales (t-1), R&D ratio (t-1), debt ratio (t-1),
Advertising ratio(t-1) and the scores for each CSR dimension.

4.2 The relationship between CSR and financial performance in a dynamic framework

We estimate the relationship between CSR scores and financial performance using the dynamic Generalised Method of Moments (GMM) estimator, called system GMM (see Blundell and Bond, 1998).

The system GMM estimator extends the GMM in differences (Arellano and Bond, 1991) by estimating a system of both first-difference equations and level equations with a wider set of instruments. We need to rewrite the dynamic model of Eq.(4) in a first-differenced form:

$$\Delta\Pi_{it} = \alpha + \beta\Delta\Pi_{it-1} + \gamma\Delta CSR_{it} + \delta\Delta X_{it} + \Delta\varepsilon_{it} \quad (2)$$

This dynamic modelling approach has been used in empirical analyses where the structure of the problem suggests both a dynamic relationship between the dependent and independent variables and an endogeneity issue (see among others Hoechle et al.; 2012, Wintoki et al., 2012). Unlike traditional fixed-effects estimates, the dynamic panel system GMM estimator allows current CSR scores to be influenced by previous realisations of past financial performance. Ignoring both unobservable heterogeneity (as in the pooled OLS model) and the

dynamic CSR-financial performance relationship (as in the fixed-effects model) may create some biases. An important aspect of the system GMM methodology is that it relies on a set of internal instruments. In particular past values of CSR scores and financial performance can be used as internal instruments for current realisations of CSR. This method partially eliminates the need for external instruments. Here we include the lagged value of financial performance in the model, and we use historical financial performance and the other firm control variables (i.e. ltotal assets, lsales, R&D ratio, debt ratio and advertising ratio) lagged for two periods as instruments for the endogenous CSR variables. Thus, the system GMM estimator allows us to obtain consistent estimates by controlling for unobserved heterogeneity, fixed effects, simultaneity and endogeneity.

Two conditions are required for estimators to be consistent (see Arellano and Bond, 1991). The first one is a test of second-order serial correlation. In order to control for the dynamic aspects of our empirical relationship, any historical value of financial performance beyond the lags we have introduced in the estimation is a potentially valid instrument since it will be exogenous to current financial performance shocks. If this assumption is valid, by construction the residuals in first differences (AR(1)) should be correlated, but there should not be serial correlation in second differences (AR(2)). The second test is a Hansen test of over-identification which yields a J-statistic distributed under the null hypothesis of the validity of our instruments. Since the system GMM estimator uses multiple lags as instruments, their validity must be guaranteed.

Note that the econometrics literature highlights some limitations of such a dynamic panel estimation methodology: relying on the firm's history (lags of dependent and independent variables) for identification may induce a potential bias of weak instruments (Staiger and Stock, 1997, Stock and Yogo, 2005). Our paper contributes to this literature by discussing the conditions under which the system GMM estimator improves inference beyond traditional OLS and fixed-effects estimates in a dynamic framework.

5 Results

The first step of our empirical investigation consists of providing direct empirical evidence of the dynamic relationship between CSR scores and financial performance. We use ROA as a measure of financial performance (see Table 9) and replicate all these estimations using Tobin's Q (see Table 10) to assess whether our results are sensitive to specific financial performance indicators. We compare the results using the system GMM estimator with the ones from static OLS and fixed-effects models in order to identify the biases that may arise from ignoring the dynamic dimension of such a relationship. Moreover, in order to test for a specific relationship between CSR and financial performance in controversial sectors, we estimate a traditional fixed-effects model. Finally, we directly test for pairwise complementarity and substitutability between the different CSR ratings.

5.1 The CSR-Financial Performance Relationship

Table 9 displays static pooled OLS and fixed-effects estimates and then dynamic pooled OLS and system GMM estimates when financial performance is measured by the ROA, using both the CSR scores for each CSR dimension and the aggregate CSR score (for CSR global, only the system GMM estimations are reported here but our additional estimations are available upon request)[9]. Results when financial performance is measured by the Tobin's Q are displayed in Table 10. For the system GMM estimator, we validate the two previously presented standard tests on misspecification: the second-order serial correlation test (the AR(2) test) and the Hansen test of other-identifying restrictions.

The positive and significant coefficient of the lagged dependent variable confirms that financial performance is persistent, I.e. financial performance depends substantially on its own past realisations. The results show that regardless of the estimation methodology, there are no significant differences for the firm control variables. We find that both sales (i.e. size) and DJSTOXX600 index listing have a positive impact on financial performance. We find a negative impact of R&D intensity and of the advertising ratio on ROA. The debt ratio indicates mixed results, which have been extensively explored in the literature, since these two measures represent different opportunities for a firm. When we compare the estimates for the ROA and the Tobin's Q, we find a negative relationship between debt ratio and ROA and a positive relation with Tobin's Q, but the latter coefficient is only significant at 10%. This may be interpreted by the fact that, on one hand, higher levels of debt are expected to have a negative impact on financial performance for instance due to increased interest expenses and thus increases in costs associated with financing the firm's strategy (see e.g. Hall and Weiss, 1967). On the other hand, debt may also play a positive role in alleviating agency problems by helping to discourage over-investment of free cash flow by self-serving managers (see e.g. Jensen, 1986, Stulz, 1990, or Harvey et al., 2004).

The estimates for the CSR scores depend on the model used. We can see that ignoring both unobservable heterogeneity (pooled OLS model) and the dynamic CSR-financial performance relationship (fixed-effects model) may create some biases. For instance the OLS and fixed-effects estimates suggest a negative relationship between the human resources score (HR) and financial performance, whereas the system GMM estimation reveals a positive relationship. Thus, it is worth considering dynamics when estimating the CSR-financial performance relationship. Since the OLS estimates and fixed-effects model may provide biased results, we focus our comments on the system GMM results.

9 Estimations were carried out using the Stata module Xtabond2 developed by D. Roodman (2006).

Table 9: The effects of CSR scores on financial performance (ROA)

Variables	Pooled OLS (Static)	Fixed-effects (Static)	Pooled OLS (Dynamic)	System GMM (Dynamic)	System GMM (Dynamic)
ROA (t-1)			0.556***	0.306***	0.229***
			(0.026)	(0.051)	(0.091)
HR score	-0.004	-0.004	0.001	-0.019*	
	(0.005)	(0.004)	(0.005)	(0.010)	
ENV score	0.008*	0.007*	0.008*	0.030***	
	(0.005)	(0.004)	(0.004)	(0.011)	
BB score	0.003	0.005**	0.001	0.003	
	(0.003)	(0.002)	(0.002)	(0.005)	
ENV*HR scores	-0.001***	-0.001***	-0.001***	0.000	
	(0.000)	(0.000)	(0.000)	(0.001)	
ENV*BB scores	0.001	-0.000	0.001	-0.001***	
	(0.001)	(0.000)	(0.001)	(0.000)	
HR*BB scores	0.001	0.001	0.001	0.001***	
	(0.001)	(0.001)	(0.001)	(0.000)	
CSR global					-0.233***
					(0.082)
Ltotal assets	-0.326***	-0.316**	-0.170***	-0.466***	-0.243***
	(0.040)	(0.044)	(0.033)	(0.128)	(0.059)
Lsales	0.253***	0.296***	0.136***	0.468***	0.205***
	(0.037)	(0.042)	(0.029)	(0.130)	(0.051)
R&D ratio	-0.045*	-0.072*	-0.357	-0.543	-0.239
	(0.025)	(0.038)	(0.561)	(0.441)	(0.031)
No&RD	0.149	0.319	0.203	0.107	0.148
	(0.113)	(0.235)	(0.094)	(0.169)	(0.112)
Debt ratio	-0.206***	-0.191***	-0.096***	-0.071**	-0.059*
	(0.024)	(0.026)	(0.020)	(0.036)	(0.032)
DJSTOXX600 index	0.258***		0.167***	0.155**	0.245***
	(0.076)		(0.062)	(0.082)	(0.034)
Advertising ratio	-0.031*	-0.043**	-0.017	-0.071**	-0.038
	(0.017)	(0.021)	(0.022)	(0.034)	(0.030)
Year dummies	Yes	Yes	Yes	Yes	Yes
Sectors dummies	Yes	No	Yes	Yes	Yes
Countries dummies	Yes	No	Yes	Yes	Yes
R^2	0.221	0.206	0.486		
AR1				p = 0.000	p = 0.010
AR2				p = 0.590	p = 0.345
Hansen test				p = 0.781	p = 0.556

Robust standard errors in parentheses
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Table 10: The effects of CSR scores on financial performance (Tobin's Q)

Variables	Pooled OLS (Static)	Fixed-effects (Static)	Pooled OLS (Dynamic)	System GMM (Dynamic)	System GMM (Dynamic)
Tobin's Q (t-1)			0.575***	0.474***	0.477***
			(0.157)	(0.049)	(0.052)
HR score	-0.007**	-0.006**	0.002	0.013***	
	(0.003)	(0.003)	(0.003)	(0.003)	
ENV score	0.002	0.007	0.004	0.002	
	(0.003)	(0.005)	(0.002)	(0.003)	
BB score	0.003	0.002	0.001	0.004	
	(0.002)	(0.001)	(0.001)	(0.003)	
ENV*HR scores	-0.001	-0.001***	-0.001***	-0.001***	
	(0.0003)	(0.001)	(0.000)	(0.000)	
ENV*BB scores	0.001	-0.001**	0.001	-0.001***	
	(0.001)	(0.000)	(0.001)	(0.000)	
HR*BB scores	0.001**	0.001**	0.001*	0.001***	
	(0.000)	(0.000)	(0.000)	(0.000)	
CSR global					-0.103***
					(0.036)
Ltotal assets	0.290***	-0.318***	-0.200***	-0.153***	-0.127**
	(0.026)	(0.029)	(0.056)	(0.025)	(0.059)
Lsales	0.068***	0.136***	0.048**	0.044**	0.055
	(0.024)	(0.029)	(0.027)	(0.019)	(0.060)
R&D ratio	1.016***	1.013***	1.047***	1.283***	1.289***
	(0.515)	(0.317)	(0.257)	(0.503)	(0.420)
No&RD	-0.185	-0.099	-0.113	-0.187	0.099
	(0.169)	(0.083)	(0.071)	(0.167)	(0.102)
Debt ratio	-0.016	0.007	0.123*	0.127*	0.151
	(0.012)	(0.11)	(0.071)	(0.070)	(0.113)
DJSTOXX600 index	0.344***		0.211***	0.196***	0.148***
	(0.048)		(0.073)	(0.045)	(0.039)
Advertising ratio	0.045***	0.038***	0.008	0.011	0.020
	(0.012)	(0.013)	(0.007)	(0.010)	(0.021)
Year dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	No	Yes	Yes	Yes
Countries dummies	Yes	No	Yes	Yes	Yes
R^2	0.305	0.231	0.781		
AR1				p = 0.008	p = 0.006
AR2				p = 0.336	p = 0.301
Hansen test				p = 0.667	p = 0.684

Robust standard errors in parentheses
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Regarding the sign of the relationship between CSR scores and financial performance, we see that a high performance on human resources (HR score) has a negative impact on the ROA, but a positive impact on the Tobin's Q. Since the Tobin's Q can be more appropriate to capture the value of long-term investments, it seems that investors evaluate positively such a social commitment. However, being environmentally friendly (ENV score) enhances only the ROA. Thus, financial performance measures matter since we find differentiated impacts on accounting (ROA) versus market-based (Tobin's Q) measures of financial performance. The aggregate measure of CSR (CSR global) has a negative impact on financial performance for both the ROA and the Tobin's Q. This result highlights that it is worth taking into account the different dimensions of CSR in order to understand the relationship between CSR and financial performance. Moreover, we also see that a high score simultaneously on human resources and environment has a negative impact on the Tobin's Q (the interaction term ENV*HR is negative and significant), and the interaction between environmental and business behaviour (ENV*BB scores) has a negative impact on the ROA. However, we find a positive effect for the interaction term between human resources and business behaviour (HR*BB) scores. We find similar results for the Tobin's Q.

These primary findings suggest some kind of trade-offs between the different CSR components. For instance, firms with responsible supply chain management should not invest simultaneously in environmentally friendly processes (it will lower financial performance) but they can have social commitment. In terms of promoting financial performance, there seem to be some conflicts among stakeholders (supply chain associates and the environment), and synergies among others (supply chain associates and employees). However, CSR commitment may differ across sectors. Thus, we need to test for industrial patterns and provide some insights into the CSR-financial performance relationship in controversial sectors, as well as test the robustness of these primary results.

5.2 The CSR-financial performance relationship in controversial industries

Are there any industrial patterns that may affect the link between CSR and financial performance? As reported previously, Table 5 indicates that some dimensions of CSR may be more important in specific industries and less in others. This section proposes some insights into this issue. Recent studies emphasise the importance of CSR in controversial sectors such as tobacco and alcohol, or industries involved with emerging environmental, social or ethical issues (i.e. weapons, nuclear, oil, cement or biotech). As pointed out by Cai et al. (2012), CSR commitment is positively associated with financial performance in controversial industries although their products might be detrimental to the environment, human beings and society. Managers of firms in controversial industries may in fact use CSR as a means to enhance their reputation (Goel and Thakor, 2008). Table 11 displays static fixed-effects estimates using both the ROA and the Tobin's Q as financial performance indicator, by separating controversial industries from the others[10].

10 We have only 330 firm-year observations for the controversial industries sample, thus, we cannot estimate a system GMM model.

Table 11: CSR and financial performance in controversial industries: Fixed effects models

Variables	ROA (Sin sectors)	ROA (Other sectors)	Tobin's Q (Sin sectors)	Tobin's Q (Other sectors)
HR score	-0.132**	0.049	-0.002	0.005
	(0.066)	(0.079)	(0.006)	(0.004)
ENV score	0.193**	-0.121*	0.012**	-0.008**
	(0.096)	(0.063)	(0.005)	(0.003)
BB score	-0.099	0.215***	-0.001	0.015***
	(0.082)	(0.067)	(0.002)	(0.004)
ENV*HR scores	-0.0014	0.003**	-0.001**	0.001**
	(0.001)	(0.001)	(0.000)	(0.000)
ENV*BB scores	-0.003*	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.001)	(0.001)
HR*BB scores	0.004**	-0.003**	0.001	-0.001**
	(0.001)	(0.001)	(0.001)	(0.000)
CSR global	-0.284**	-0.306***	-0.111**	-0.135**
	(0.121)	(0.074)	(0.046)	(0.032)
Year dummies	Yes	Yes	Yes	Yes
R^2	0.429	0.344	0.441	0.459

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

The other control firm variables included in the estimations but not reported here are: Ltotal assets, Lsales, R&D ratio, debt ratio and advertising ratio(t-1).

Here, given the nature of our data, we can only identify as potentially controversial industries (sin sectors) firms belonging to the energy, automobile, transport and agri-food sectors (see Table 5). We do find different industrial patterns when we compare the results for controversial industries with others. We find a negative and significant effect of the aggregate measure of CSR (CSR global) for both financial performance indicators in controversial industries and in the others. However, controversial industries are more likely to invest in the environment (ENV score) rather than human resources (HR score) compared to the other sectors. When financial performance is measured with the ROA in controversial industries, human resources (HR) and business behaviour (BB) scores appear as joint inputs of financial performance, whereas the environmental dimension does not interact positively with the two other CSR dimensions, suggesting conflicts between voluntary business and involuntary non business stakeholders. This may mean that firms in controversial industries are likely to adopt a specific investment strategy regarding the environment in order to enhance their reputation. For the other industries, human resources (HR) and environmental (ENV) scores are rather joint inputs of financial performance and firms invest significantly more in the business behaviour dimension (BB score), suggesting less conflicts among (business and non business) stakeholders. We find similar effects for the Tobin's Q estimates.

Our results give some partial insights and confirm the recent studies that show the importance of CSR commitment in controversial industries. Thus, industrial patterns in CSR

commitment should be taken into account when we consider the CSR-financial performance relationship. For this purpose, a complementary analysis of the robustness to our previous estimations is to estimate simultaneously the impact of the different CSR dimensions by using the industry-adjusted ratings rather than the CSR scores and then to directly and explicitly test for complementarities between these different dimensions.

5.3 Testing for complementarity between the different CSR industry-adjusted ratings

To explicitly test our three hypotheses (see section 2), we must control for the firm's industry. Thus, we need to use the firm's relative CSR rankings within the sector (and not the CSR scores, which do not take into account the firm's industry or sector). For this purpose, we rely on a dummy variable that takes the value of 1 (resp. 0) if the firm is ranked above (resp. below) the sectoral average on the corresponding CSR dimension. The interest of such relative rankings is multiple: they represent a measure allowing comparisons across sectors and across various CSR dimensions, they can thus be considered as CSR industry-adjusted ratings and contrary to CSR scores they cannot be affected by some potential multicollinearity (see Table 7). Given that we have three CSR dimensions (HR, ENV and BB), we need to identify clusters of ratings as follows. We define 8 dummy variables, labelled 'CSR states', by following the convention of binary algebra: these variables are equal to 1 when the firm obtains a rating above sectoral average on one, two or three CSR dimensions, and zero otherwise. Definition and descriptive statistics for the eight CSR states are reported in Table 12. We can see that the most frequent state is the extreme one - best performance on all CSR dimensions (45%), whereas the other states are uniformly distributed.

Table 12: CSR states

CSR states	State	%
Ranking below sectoral average on the three dimensions	State000	9
Ranking above sectoral average on Human Resources (HR)	State100	5
Ranking above sectoral average on Environment only (ENV)	State010	5
Ranking above sectoral average on Business Behaviour (BB)	State001	8
Ranking above sectoral average on HR and ENV	State110	12
Ranking above sectoral average on HR and BB	State101	8
Ranking above sectoral average on ENV and BB	State011	8
Ranking above sectoral average on the three dimensions	State111	45

Table 13 displays the regression analysis for the system GMM estimator using CSR states dummies. As for previous estimations, the set of instruments is composed of the dependent variable, the CSR states (dummies) and the control variables, all lagged over two periods. The Arellano and Bond test on autocorrelation supports the overall validity of the model by providing evidence of first order autocorrelation (AR1) and the absence of second order autocorrelation (AR2) while the Hansen test supports the consistency of the GMM instruments. Thus, our estimation controls properly for potential correlation between unobserved factors and the regressors.

Regarding the traditional determinants of financial performance (ROA and Tobin's Q) and its persistence, we obtain the same results as in Tables 10 and 11. Regarding the CSR states dummies, considering the reference state (State000: all CSR ratings below sectoral average) we observe some significant positive states on financial performance: being above sectoral average in human resources (HR) and business behaviour (BB) (State101) and in environment (ENV) and business behaviour (BB) (State011) increases ROA. These results may highlight that the business behaviour (BB) dimension can be considered as the component that can be more easily matched with the other two CSR components. Significant at 10%, we have the State111 (ratings above sectoral average on the 3 CSR dimensions) and State110 (ratings above sectoral average on human resources and environment). Sectoral leadership simultaneously on the three CSR dimensions (State111) is likely to enhance financial performance. For the Tobin's Q only State100 (rating above sectoral average on human resources) is significantly positive.

As pointed out by Mohnen and Roller (2005), the individual significance and signs of the state coefficients do not directly reveal whether CSR components are complementary or substitutable for two reasons. First, complementarity involves testing linear restrictions on several coefficients. Second, complementarity requires testing the joint distribution of several of these linear restrictions. For both reasons, it is possible that all coefficients are statistically insignificant, even though the joint hypothesis for complementarity is accepted. Several alternative empirical testing procedures have been derived to formally examine discrete complementarity among business practices (see Athey and Stern, 1998 for an overview). Here, we follow the 'productivity approach' which has been implemented especially in the innovation literature with a precise examination of multiple complementarities (see e.g. Leiponen, 2005; Mohnen and Roller, 2005; Belderbos et al., 2006 or Lucena, 2011). This approach relies on a direct test of supermodularity.

The theory of supermodularity establishes that two or more dimensions are complements when using one more intensely increases the marginal benefit of using others more intensively, that is when 'the whole is more than the sum of its parts' (see Milgrom and Roberts, 1995). When there are more than two dimensions, an important result from the theory of supermodularity states that a function is supermodular over a subset of its argument if and only if all pairwise components in the subset are complementary. In other words, when there are more than two dimensions it suffices to check for pairwise complementarities (see Topkis, 1978; Mohnen and Roller, 2005).

In order to empirically identify discrete complementarities between CSR states, we follow Mohnen and Roller (2005) and we use the methods developed by Kodde and Palm (1986), applied for instance by Leiponen (2005). Given the definition of the CSR states in Table 12, we write the inequality constraints for supermodularity as a set of restrictions on the estimates of the coefficients on the CSR states. We need to test jointly for the set of six inequality constraints on the CSR states coefficients. The tests for complementarity (supermodularity) and substitutability (submodularity) are joint one-sided Wald tests of the constraints.

Table 13: CSR states and financial performance: System GMM

Variables	ROA	Tobin's Q
ROA(t-1)	0.356**	
	(0.180)	
Tobin's Q (t-1)		0.557***
		(0.117)
State000	Ref.	Ref.
State111 (HR, ENV & BB) [a]	0.645*	0.166
	(0.351)	(0.173)
State110 (HR & ENV) [b]	0.676*	0.316
	(0.410)	(0.203)
State100 (HR)	0.471	0.419**
	(0.421)	(0.205)
State001 (BB)	0.571	0.192
	(0.452)	(0.235)
State010 (ENV)	0.476	0.266
	(0.443)	(0.228)
State011 (ENV & BB)	1.075***	0.333
	(0.412)	(0.220)
State101 (HR & BB)	0.743**	0.108
	(0.389)	(0.218)
Ltotal assets	-0.262***	-0.174***
	(0.071)	(0.044)
Lsales	0.186***	0.066***
	(0.061)	(0.022)
R&D ratio	-0.470	1.603***
	(0.877)	(0.318)
NoR&D dummy	-0.002	0.016
	(0.078)	(0.027)
Debt ratio	-0.145***	0.235**
	(0.049)	(0.120)
DJSTOXX600 index	0.151*	0.156***
	(0.900)	(0.051)
Advertising ratio	-0.023	-0.054
	(0.020)	(0.044)
Year dummies	Yes	Yes
Sector dummies	Yes	Yes
Countries dummies	Yes	Yes
AR1	p = 0.001	p = 0.009
AR2	p = 0.286	p = 0.297
Hansen test	p = 0.799	p = 0.659

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

a: Ratings are above sectoral average on the three CSR dimensions.

b: Ratings are above sectoral average on human resources and environment.

Considering the estimates of the coefficients on the CSR state variables β_{ijk}, the inequality constraints on the coefficients supporting supermodularity (that is complementarity) and the corresponding null (H_0) versus alternative (H_a) hypotheses to be tested are written:

- [HR & ENV] supermodular:

$$\beta_{111} - \beta_{101} \geq \beta_{011} - \beta_{001} \quad \text{and} \quad \beta_{110} - \beta_{100} \geq \beta_{010} \tag{3}$$

Supermodularity test (complementarity):

$H_0 : \beta_{11i} + \beta_{00i} - (\beta_{01i} + \beta_{10i}) \geq 0$ against $H_a : \beta_{11i} + \beta_{00i} - (\beta_{01i} + \beta_{10i}) \ngeq 0$, i=0,1

- [HR & BB] supermodular:

$$\beta_{111} - \beta_{011} \geq \beta_{110} - \beta_{010} \quad \text{and} \quad \beta_{101} - \beta_{001} \geq \beta_{100} \tag{4}$$

Supermodularity test (complementarity):

$H_0 : \beta_{1i1} + \beta_{0i0} - (\beta_{0i1} + \beta_{1i0}) \geq 0$ against $H_a : \beta_{1i1} + \beta_{0i0} - (\beta_{0i1} + \beta_{1i0}) \ngeq 0$, i=0,1

- [ENV & BB] supermodular:

$$\beta_{111} - \beta_{101} \geq \beta_{110} - \beta_{100} \quad \text{and} \quad \beta_{011} - \beta_{001} \geq \beta_{010} \tag{5}$$

Supermodularity test (complementarity):

$H_0 : \beta_{i11} + \beta_{i00} - (\beta_{i01} + \beta_{i10}) \geq 0$ against $H_a \beta_{i11} + \beta_{i00} - (\beta_{i01} + \beta_{i10}) \ngeq 0$, i=0,1

Note that we use $\beta_{000} = 0$. Moreover, in the three cases, submodularity tests (substitutability) are written H_0: … ≤ 0 against H_a: …. ≰ 0

Testing for pairwise complementarity under the null hypothesis, and considering that the test for supermodularity is a one-sided test of a given pair of inequality, we thus compute a distance measure and compare it with lower and upper bound critical values for the distance test or Wald test. Values of the Wald test below the lower bound critical value imply that the null hypothesis is accepted. Values above the upper bound critical value yield a rejection of the null hypothesis. Values in between the two bounds imply that the test is inconclusive.

Table 14 presents the results of the joint tests for these inequality restrictions.

Table 14: Tests for supermodularity (complementarity) and submodularity (substitutability)

Hypothesis	Supermodularity test		Submodularity test	
	ROA	Tobin's Q	ROA	Tobin's Q
Human resources and environment	0.191	0.377*	4.18e-09*	0.121*
Human resources and business behaviour	0.025**	1.53e-012**	3.063	3.367
Environment and business behaviour	1.695	0.653	0.206*	0.135*

Based on Kodde and Palm (1986).
The critical values provided by Kodde and Palm for α=0.25 are: 0.455 and 2.090.
The values marked * support the null hypothesis of supermodularity or submodularity.
The values marked ** support the null hypothesis of supermodularity and reject the null hypothesis of submodularity

Table 14 should be interpreted as follows. If the test value is below 0.455, the null hypothesis of supermodularity (submodularity) is accepted, and if the test value is above 2.090, the null hypothesis is rejected (at $\alpha = 0.25$, the same level as used by Leiponen, 2005). For test values between the two critical values, the test is inconclusive. When supermodularity can be accepted and submodularity rejected simultaneously, there is evidence for strict supermodularity. When supermodularity can be accepted but the submodularity test is inconclusive, the evidence for strict supermodularity is weaker. Finally, when both supermodularity and submodularity can be accepted simultaneously, strict supermodularity is rejected.

We therefore have the following results. First, note that the results in terms of complementarity and substitutability are identical whether they are based on the ROA or the Tobin's Q. These results confirm that complementarity in fact matters in the relationship between CSR and financial performance. However contrary to previous results, robustness tests of complementarity do not appear sensitive to the measure of financial performance used.

Regarding the nature of interactions among each CSR dimension, the results of the test show that for human resources (HR) and environment (ENV) the test is inconclusive. For human resources (HR) and business behaviour (BB) the null hypothesis of supermodularity fails to be rejected and the null hypothesis of submodularity is rejected, supporting strict supermodularity (or complementarity). For environment (ENV) and business behaviour (BB), the supermodularity test is inconclusive and the null hypothesis of submodularity fails to be rejected, supporting weak submodularity (or substitutability).

Simply stated, we show that one pair of CSR practices is substitutable: environment (ENV) & business behaviour (BB); and one pair of CSR practices is complementary: human resources (HR) & business behaviour (BB). In other words, our hypothesis 1 (complementarity explained by the conflict-resolution hypothesis) is confirmed for the human resources and business behaviour pair, but it is not valid for the other pairs (human resources and environment; environment and business behaviour). Our hypothesis 2 (substitutability explained by the over-investment hypothesis) is confirmed for the environment and business behaviour pair, but it is not valid for the other pairs. And finally, our hypothesis 3 is confirmed: CSR practices are complementary inputs of financial performance when they positively affect voluntary business stakeholders (mutual benefit between practices towards employees and supply chain associates, since human resources and business behaviour are relative complements) and they are substitutable inputs of financial performance when they positively affect voluntary business and involuntary non-business stakeholders (conflicts between practices towards supply chain associates and the environment). Overall, the new stakeholder theory appears consistent with our data on CSR and financial performance in publicly traded European firms. This is summarised in Table 15.

Table 15: Summary of results

Hypothesis	HR & ENV	HR & BB	ENV & BB
H1: Complementarity (conflict-resolution)	No	Yes	No
H2: Substitutability (over-investment)	No	No	Yes
H3: New Stakeholder Theory	No	Yes (mutual benefit)	Yes (conflicts)

6 Concluding remarks

No consensus has been reached so far on whether or not CSR leads to higher financial performance. We provide one potential explanation for this absence of conventional wisdom which hides a double phenomenon: high performance in firms implementing complementary CSR practices, and low performance in firms implementing substitutable CSR practices. This study provides an original contribution to the existing literature as we show that the nature of complementarity or substitutability between different CSR practices matters in the CSR-financial performance relationship. In particular human resources and business behaviour towards customers and suppliers are relative complements, whereas environment and business behaviour towards customers and suppliers are relative substitutes.

From a theoretical perspective, our results confirm that some domains of CSR yield mutual benefits and less conflicts among stakeholders (especially between employees and supply chain associates), while other domains yield more conflicts or over-investment among stakeholders (especially between supply chain associates and the environment).

For researchers interested in the CSR-financial performance relationship, our results imply that empirical models estimating the impact of any one CSR policy on financial performance will likely yield biased coefficients due to the omission of the other CSR variables. It is therefore important to take into account the various dimensions of firms' CSR strategies and the interaction among those dimensions, but also to control for industry. Moreover, estimates of the impact of any global CSR measure may hide conflicting relations among sub-domains, in the form of high performance when adopting complementary practices simultaneously and low performance when adopting substitutable practices simultaneously.

For managers of companies deciding to invest in CSR, two types of business models are valued by investors. In the first business model, synergies are exploited by developing CSR strategies focused jointly on human resources and the supply chain, which yield mutual benefits and reduce conflicts among those stakeholders. According to the second business model, it is better to develop CSR strategies focused on either the environment or the supply chain (business behaviour) rather than combining both dimensions simultaneously, due to conflict among those stakeholders or over-investment. Finally, while we find that it is worth taking into account the several dimensions of CSR, we do not investigate more deeply the subcriteria behind each broad domain. This analysis would prove a useful investigation of the CSR-financial performance missing link as is the case in Scholtens (2008) for instance.

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